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Estimating Dbh from Stump Diameter for 15 Southern Species

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SUMMARY

Regression equations for predicting dbh from tree stump diameter inside and outside bark are presented for 15 southern species. Equations were verified on independent test subsets using the F distribution statistic with a significance level of .05.

Additional keywords: Dbh, stump diameter.

INTRODUCTION

The Southern Forest Renewable Resources Unit needed an accurate prediction of diameter breast height (dbh) from stump dimensions to estimate the dbh of removals. From the existing information on dbh, volume of the removals could be calculated using existing volume equations or volume tables.

Dbh estimation has several other applications such as: (1) predicting removals from a large forested area, (2) predicting total volume of timber resulting from trespass cutting, (3) aiding in the calculation of basal area distribution, and (4) calculating growth on cut as part of a forest inventory.

Although, previous studies predicting dbh from stump dimensions are numerous, none of the studies were done in the Midsouth region of the U.S.A. Only McClure's (1968) report included species of interest to the Midsouth, but his study was conducted in the Southeast. Charts and graphs dominated the earlier studies (Hough 1930, Rapraeger 1941, and Endicott 1959), while regression techniques are used frequently today (Myers 1963, McClure 1968, and Raile 1977).

Data Set

Data used in this study were gathered in Louisiana (1973) as part of a wood utilization study. The number of samples ranged from 436 for loblolly pine to 14 for yellow-poplar. A species test subset was extracted from every species data set which contained more than 30 sample trees. The majority of the trees were sawtimber size with mean dbh of 12.7 inches for softwoods and 14.4 inches for hardwoods. The mean stump height was 0.8 feet for softwoods and 1.0 feet for hardwoods (table 1).

METHODS

Simple linear regression equations were developed to predict dbh from stump diameter inside bark or outside bark. Raile's and McClure's models, which are more complex (both used variable stump height), were tested on slash pine and sweetgum data sets. Examination of the R^2's and standard errors indicated that simple linear regression equations predicted dbh with accuracy comparable to Raile's and McClure's models. Analyses of the distribution of residuals for all three models also indicated the adequacy of simple linear model.

RESULTS

Equations predicting dbh from stump diameter outside bark were slightly more accurate than those equations using stump diameter inside bark (table 2). Dbh was predicted better for the softwoods than for hardwoods.

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Table 1.—*Mean, range*[1]*, and number of samples for selected parameters in the data sets*

Species	No. samples	Dbh (inches)		Stump height (feet)		Stump diameter (inches)	
		Mean	Range	Mean	Range	Inside bark range	Outside bark range
Slash Pine	134	9.6	3.4–17.2	.7	0.4–1.2	3.6–27.2	4.8–29.1
Shortleaf Pine	196	12.8	4.5–23.5	.7	0.2–1.2	4.4–24.0	5.3–26.1
Longleaf Pine	42	13.3	7.5–19.4	.7	0.5–1.3	7.1–20.3	8.5–23.4
Loblolly Pine	436	13.5	3.0–27.0	.8	0.1–1.5	3.3–28.8	4.2–31.3
All Pines	914	12.7	3.0–27.0	.8	0.1–1.5	3.3–32.5	4.2–35.4
Hickory	36	15.0	6.7–24.2	1.1	0.5–1.5	7.9–26.7	9.0–28.2
White Oak	72	13.9	6.3–23.3	1.1	0.1–2.1	7.4–26.1	7.9–27.5
Water Oak	62	16.8	6.6–36.9	1.1	0.5–1.8	8.3–41.6	9.0–43.2
Post Oak	68	11.6	4.1–22.6	.9	0.5–1.5	4.9–27.4	6.0–29.0
Cherrybark Oak	28	15.0	7.3–28.5	1.1	0.5–1.5	8.7–32.1	9.4–34.3
S. Red Oak	89	11.8	4.4–22.0	1.0	0.4–2.9	4.7–25.9	5.2–27.4
Sweetgum	119	12.7	4.0–41.4	1.0	0.3–1.5	4.9–27.4	5.3–28.5
Black Tupelo	21	13.2	6.6–20.2	1.1	0.3–1.5	8.7–26.4	9.6–27.3
Yellow-poplar	14	17.3	15.3–22.5	1.0	0.5–1.5	16.2–23.4	17.6–25.2
Sugarberry	21	15.8	8.4–26.2	1.4	1.0–2.5	12.9–32.1	13.7–33.7
Beech	15	16.4	8.9–21.9	1.2	0.7–1.5	10.5–25.9	10.9–27.0
Other Hardwood	111	14.4	4.4–29.8	1.0	0.3–1.5	5.2–34.9	5.8–36.5
All Hardwood	619	13.8	4.0–41.4	1.0	0.1–2.9	4.7–43.4	5.2–45.3

[1]Due to the selection of test subsets, ranges for all-pines and all-hardwoods data sets may differ from species ranges.

Table 2.—*Coefficients, standard error, and R^2 of equation predicting dbh*

Species	No. samples	Dbh = b_0 + b_1*SDOB[1]				Dbh = b_0 + b_1*SDIB[2]			
		b_0	b_1	SE	R^2	b_0	b_1	SE	R^2
Slash Pine	134	−.055	.808	.74	.96	.518	.902	.78	.95
Shortleaf Pine	196	.178	.851	.75	.97	.796	.910	.88	.96
Longleaf Pine	42	.489	.841	.87	.92	1.048	.921	.96	.91
Loblolly Pine	436	−.255	.854	.99	.96	.601	.902	1.03	.96
All Pines	914	−.196	.853	.98	.96	.668	.902	1.01	.95
Hickory	36	.413	.811	1.26	.90	1.317	.840	1.31	.90
White Oak	72	.152	.776	1.36	.84	.610	.811	1.37	.84
Water Oak	62	1.146	.725	1.79	.91	1.438	.749	1.82	.91
Post Oak	68	−.107	.773	1.16	.93	.471	.820	1.17	.93
Cherrybark Oak	28	.652	.766	1.21	.95	.815	.808	1.23	.95
S. Red Oak	89	.422	.746	1.30	.88	.885	.792	1.33	.87
Sweetgum	119	−.196	.818	1.02	.94	.222	.840	1.07	.93
Black Tupelo	21	.444	.768	.98	.94	.855	.798	1.07	.93
Yellow-poplar	14	.366	.851	.90	.95	.449	.905	.93	.95
Sugarberry	21	1.033	.699	1.82	.81	1.305	.720	1.83	.81
Beech	15	1.182	.777	2.00	.71	1.106	.860	2.02	.70
Other Hardwood	111	.515	.776	1.36	.93	.902	.804	1.41	.92
All Hardwood	619	.595	.757	1.43	.90	1.203	.777	1.48	.90

[1] SDOB = stump diameter outside bark.
[2] SDIB = stump diameter inside bark.

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The equations (table 2) were applied to each species' respective test subset. Examining the residuals, the F-test with .05 significance level failed to reject any of the equations. Although the F-test failed to reject water oak equations, these equations underestimated dbh of larger diameter trees. This possibly reflects swelling of the butt log characteristic in this species.

The user of these coefficients and equations for prediction of dbh is warned to observe the limits for individual species indicated by the range of stump diameters (table 1). Measurement of stump diameter should be taken around the stump height mean. Extrapolation to larger diameters should be verified if warranted. It should also be noted that variability of the prediction is larger for larger stump diameters.

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